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TOOLS TO LEAD SUPPLIER PERFORMANCE IN NEW PRODUCT DEVELOPMENT PROJECT

Master of Science thesis

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ABSTRACT

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New product development is becoming vital for companies to survive in fast changing markets. Customers are demanding new products faster, with good quality and with newest technology. The case company is responding to this demand by defining their new product development process in a new way allowing open innovation be a bigger part of the process. The problem in the old process was that it was not defining the responsibilities so well and not taking into account all the actions that needed to happen at the supplier in order to achieve the time-to-market and quality targets. The problem was that the lead time of the NPD projects was too long compared to the targets and the amount of corrective actions during and after the project were too high. Since the company operates with continuous improvement they saw a big opportunity in this process development. The target of the new process is to decrease the lead time of the NPD project and maintain a stable quality level through the whole project.

The case company is developing a Supplier operations project management (SOPM) matrix to describe the whole New Product development process from supplier operations with detailed tasks in every project phase. Based on this matrix the purpose of this Master's thesis is to develop supplier operations project management tools to support the work of a supplier operations project manager who is responsible of leading suppliers in the new product development project.

This work is done when the company is still in a development phase of a new process for new product development which made it impossible to gather information if targets set to the new process were met. Developing a new process takes time and the implementation has already begun but the nature of new product development is quite long which means that to get a clear picture of the results is going to take several years. But as a clear result the tools were released for use. Estimation of the benefits of the tools is that time used before for creating the tools for working with the supplier was around 20% of the time per project manager. And now with introduced tool set that time can be completely used for actual daily work and not creating support documents.

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TIIVISTELMÄ

MIA-MARIA JAUHIAINEN: Työkalut toimittajien johtamiseen uuden tuotteen kehitysprojektissa
Tampereen teknillinen yliopisto
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Uusien tuotteiden kehittäminen on noussut tärkeään asemaan yritysten kilpaillessa jatkuvasti muuttuvilla markkinoilla. Asiakkaat vaativat uusia tuotteita nopeammin, hyvällä laadulla ja uusimmalla teknologialla. Kohdeyritys on vastaamassa tähän vaatimukseen määrittelemällä tuotekehitysprosessinsa uudella tavalla, joka antaa enemmän tilaa avoimelle innovaatiolle. Vanhan prosessin ongelmana oli vastuunjakamisen puute, eikä se ottanut huomioon kaikkia toimintoja, joita toimittajan tulee tehdä projektin aikana, jotta projektin ajalliset ja laadulliset tavoitteet saavutettaisiin. Ongelmana on, että projektin läpimenoaika oli liian pitkä verrattuna tavoitteisiin ja korjaavien toimenpiteiden määrä liian korkea. Koska yritys toimii jatkuvan parantamisen periaatteella, he näkivät suuren potentiaalin prosessin kehittämisessä. Uuden prosessin tavoitteena on lyhentää projektien läpimenoaikaa huomattavasti ja pitää yllä tasaista laatua läpi koko projektin.

Kohdeyritys on kehittämässä toimittajan toimintojen projektijohtamisen (SOPM) matriisia, joka kuvaa koko tuotekehitysprosessin toimittajien kanssa ja sisältää yksityiskohtaiset tehtävät jokaisessa projektin vaiheessa. Tämän matriisin pohjalta kehitetään toimittajan toimintojen projektijohtamisen työkalut tukemaan SOPM projektipäällikön työtä, joka on vastuussa toimittajien johtamisesta tuotekehitysprojektissa.

Tämä työ tehdään, kun yritys on vielä uuden prosessin kehitysvaiheessa, joka tekee mahdottomaksi koota tietoa koko prosessin tavoitteiden täyttymisestä. Se onnistuuko läpimenoajan lyhentäminen ja laatutason parantaminen, pystytään mittamaan vasta muutaman vuoden päästä, jolloin ensimmäiset projektit on saatettu loppuun kokonaan uudella prosessilla. Prosessin implementointi on kuitenkin jo aloitettu ja työkalut ovat käytössä. Työkalujen on alustavasti mitattu lyhentäneen dokumenttien luomiseen kuluvaa aikaa 20 %:lla projektipäällikköä kohden. Tämä vähentää hukkaan kulutettua aikaa, kun projektipäällikkö voi keskittyä dokumenttien luomisen sijaan projektin johtamiseen.

PREFACE

This thesis gave me a huge learning from the practical world that experience can only give you. Listening for hours' professionals and learning from them was a great opportunity for me and I will always appreciate this journey. First of all, I would like to thank Ari Penttinen and Giulio Molinari who were there to teach me, support me and help me to grow. Working with you was an amazing experience. Second I would like to thank Dos. Heli Aramo-Immonen for helping me with the writing part of the thesis.

Hyvinkää, 31.3.2017

Mia-Maria Jauhiainen

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LIST OF SYMBOLS AND ABBREVIATIONS

CA: Corrective Action

COT: Complete On Time

CtQ: Critical to Quality

DFM: Design for Manufacturability

ESI: Early Supplier Involvement

NPCI: New Product and Change Implementation

NPD: New Product Development

PPAP: Process Part Approval Process

PQP: Product Quality Plan

R&D: Research and Development

SOPM: Supplier Operation Project Management

VOC: Voice of Customer

1. INTRODUCTION

New Product Development has become a critical part for companies trying to survive in highly competitive markets. It is not enough anymore to have only a good idea when fighting over the customers. Companies need to also implement the idea for manufacturing and produce it with good quality and on time to markets. Customers demanding new products with short development times has increased the importance of having a good network where to get needed capabilities, technology and knowledge. This means that suppliers are becoming an important part of NPD projects.

This thesis is a part of developing the case company's new product development process to achieve shorter project lead times, to complete on time and to better support required quality level. The target is to better meet the requirements of the changing markets and its customers. Problem is that new product development process lead time is too long and amount of corrective actions during and after the project are too high. The industry sector where the case company competes is highly competitive on the time dimension where new products and new features in existing products are highly respected. The case company is designing, manufacturing and delivering high technology products globally with high quality and safety demands. This thesis is concentrating in the NPD project development from the supplier side by focusing on the following questions: How to select a right supplier for the project? How to involve the supplier in new product development projects? How to lead the supplier during the project?

Methodology of the thesis is case study which means that the thesis is solving real problems in real environment where the case company operates. Since the problems were detected but there were no clear practical answers based on the theory the methodology is more innovative and drives to think new effective ways to solve the problems. It needs a broad view of the theory behind the practice in order to develop the process and tools to support the solutions for the problems.

At first we review the theory part of the thesis which contains theory of new product development, project management and supplier project management. After theory follows the methodology description. The results are shortly described and conclusions of the thesis are showing how the questions introduced above are answered and why. The conclusions of the thesis also summarize the whole purpose of the thesis, what is learned and what should be further developed.

2. THE NEW PRODUCT DEVELOPMENT PROCESS

2.1 Turning ideas into reality without losing the value

Joe Tidd and John Bessant introduced in their book Managing Innovations (2013, p. 22) four phases of a process which will help turn ideas to be successful by managing the whole process. Those phases are: search, select, implement and capturing value. In this thesis we concentrate on the phases: implement and capturing value. The word implement in this case means how we turn the selected ideas from the earlier phases into reality so that we don't lose the value. The last phase concentrates on capturing the value of the implemented ideas.

Companies invest a lot of money to the R&D because they want to grow by developing new products (CNBC, 2016). Global competition has made it really hard for the companies to stay competitive if the company does not stay ahead of the technology and the technology is developing fast. According to Innovation 1000 study (2015) companies globally invested 680 billion dollars to research and development increasing 5,1 % from year 2014. The study also reveals that comparison between different companies showed that those who invested the most globally to R&D were performing better on financial measurements than their less globally invested competitors. Companies investing billions to R&D need to have a process and strategy for getting something back from those enormous investments. This is why companies need a good process for turning ideas into reality without losing value.

Three things have happened in new product development area. First of all, customers want more with the same price. Secondly industrialized countries with mature markets are not providing fast growth anymore. Thirdly shortened product life cycles with technology development force companies to innovate and reduce costs at the same time. These three things combined create challenges to the companies trying to achieve competitive advantage. Short product life cycles force companies to develop new products faster and launch their product with the right timing. Companies need to find new ways to innovate not only internally but also taking external partners to be involved to innovate new products together (Ili et al. 2010, 246). This increases the level of knowledge when there is a supplier involved with deep knowledge of specific technology which the company might be lacking. There is no time nor resources for companies to increase their knowledge on everything. It is more valuable for the company to concentrate on the core competencies and take partners to get the needed knowledge and capabilities from them.

A good process helps to control the NPD project and to capture the value from the investments. Next chapter introduces a model called the State-Gate that helps to manage a NPD project more structured way.

2.1.1 The State–Gate

The State–Gate model was introduced by Robert G. Cooper (1998) describing that it "is a conceptual and operational map for moving new product projects from idea to launch and beyond – a blueprint for managing the new product development process to improve effectiveness and efficiency." Cooper suggests that successful product development needs to have some kind of defined structure. Projects should go through the defined development process which includes certain gates. The gates control the process but also they control the amount of ideas going through to be implemented. One of the main challenges of the State – Gate model to make the gates work. (Cooper 2015, p. 85, 250) Every project needs resources and every company has limited resources which makes the decision of selecting the projects to be implemented important. Gates help to identify poor projects earlier and kill the projects before the company has wasted time and money for them without getting anything back. According to Cooper's research of the companies using the State-Gate model the percentage of projects meeting their sales targets is only 56 % which means that 44 % of projects are failing and those projects need investments and resources which could have been used in a better way to the projects meeting their targets. This shows that the gates are failing and letting too many bad projects through the gates to the implementation phase. (Cooper et al. 2004, p. 43 - 55)

The State-Gate model is a process showing steps and activities that are needed during the new product development project. Different company have their own versions of the State-Gate model. In some companies the model is very simple and light and others have been taking it into use as a more defined and heavier version. Also depending on the size and complexity of the project the State-Gate model can be defined differently. Complex and major projects need more stages because the risks are usually higher so the project needs to be better managed but the idea is still the same. The State-Gate model is more than a basic process flow chart by including the stages, gates, deliverables, and gate criteria so it is well-defined process going into details and not only looking the process from the high level. (Cooper 2015, p. 87)

Depending on the stage of the project the performed activities are different. In early stage the company concentrates more to defining and specifying ideas and in the later stage comes actual product manufacturing, testing and marketing. Stages are cross-functional and there are activities to different functions for example to marketing, engineering and sourcing. The function of the gate is to be decision point go / nogo and prioritizing certain activities over others. Each gate has also defined criteria which the project has to pass. The decision criteria are divided to must-have criteria and should-have criteria. Must-have criteria is something that the project really needs to have and should-have is more of a guideline what project could have in addition. Must-have is basically the critical path of the process. As an output from the gate review is the decision if the project can move to the next stage and what are the deliverables to the next gate and what is the schedule. (Cooper 2008, p. 214 - 215) The gates usually have so called gatekeepers who manage

the decision and are often cross-functional group of senior managers. Their job is to evaluate the output of the earlier stage of the project and decide whether the project can move to the next stage. If the project does not pass the specified criteria it is not allowed to continue to the next stage without doing defined corrective actions. In every gate it is important to ensure that there is structured way of reviewing both technical and marketing data. (Cooper 2015, p. 85) The deliverables consist several activities and those are usually executed by project managers with their cross-functional project team. (Cooper 2008, p. 214 - 215) Figure 1. shows the basic model of the State-Gate.

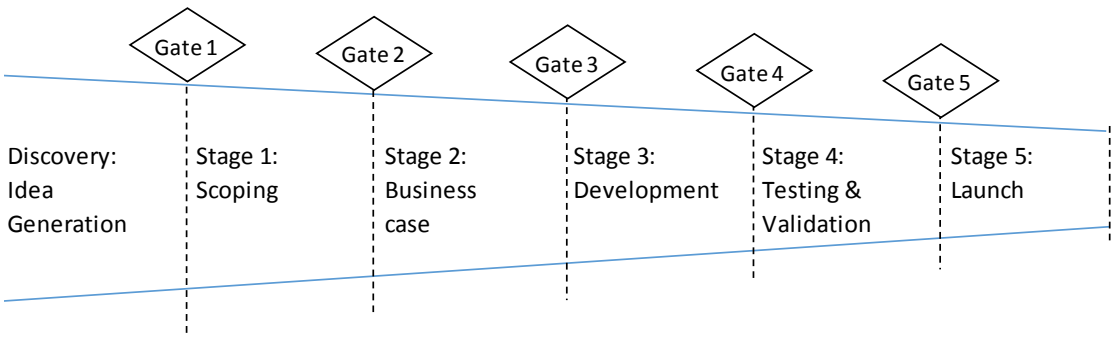

Figure 1. *Basic model of the State-Gate process by Robert G. Cooper (2015, p.101)*

Joe Tidd and John Bessant introduce their model of the State-Gate a bit differently but the basic idea is still the same. The process includes stages, gates, deliverables and decision criteria but the titles are different and taking more into account the marketing side of the project. The process starts with Idea Formulation and then from Concept Formulation to Product Development followed by test marketing and international marketing. Product Development part includes all the activities that are needed to develop a new product to the launch of that product. (2013, 410)

Each stage as shown in the figure 2. includes activities and cross-functional tasks because of different types of information needed. The main purpose of the stages is to gather required information and perform defined tasks. After each stage, there is a gate where the decisions are made before the project is able to move to the next stage. In the gate all the deliverables are assessed and based on those the decision go/ nogo is made. The gates control the process and are also functioning as a quality control. (Cooper 2015, 97-99)

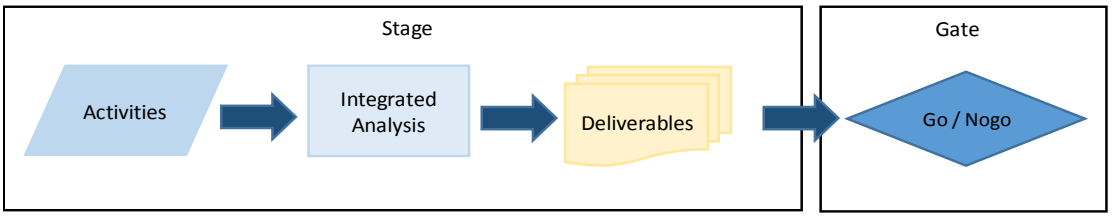

Figure 2. *The State-Gate consists of stages which include activities, analysis and deliverables followed by decision gates (Cooper 2008, 214)*

Even though the State-Gate model is used in many different companies, the researchers are still arguing about its benefits. It is not clear what is the best way to use it and if the structured way is just creating extra actions during the project. Next chapter goes through the argued benefits and difficulties of structured process.

2.1.2 Benefits and difficulties of the defined process for NPD project

Research shows that defined process for NPD projects as the State-Gate model is used by majority of companies. The State-gate model's clear advantage is to get some structure to the NPD projects and when well implemented it can speed up the project by clearly showing what needs to be done and who is responsible. (Ettlie & Elsenbach, 2007, p. 20) The State-Gate model has gathered also criticism by being time-consuming, including activities that are wasting time, having high bureaucracy and demanding much non-value-added work (Ettlie & Elsenbach, 2007; Cooper 2015). Cooper has provided improvements to the State-Gate model and it has been modified to be more efficient by removing overlapping activities, making it more flexible and faster (Grönlund et al. 2007, p. 110). But it is important to understand that the State-Gate model should not be used directly as it is. Every company is different and every project is different so that is why companies should modify the model to fit their own processes and culture (Cooper 2015, p. 110). Taking the State-Gate model into use companies need to also remember that the process needs to be reviewed and needed improvements should be done because of the changing environment over time (Ettlie & Elsenbach, 2007, p. 20). Once defined process might not be correct anymore after couple of years.

Companies have taken many improvement actions toward the State-Gate model. They have created different the State-Gate processes for different projects so that the process suits better the purpose depending on the risk level, size and complexity of the project. Some companies have taken lean manufacturing principles into the State-Gate model to reduce waste and overlapping activities. Other approaches have been also implemented to the State-Gate model like Spiral or Agile Development from Software Development. These approaches are trying to give the model more flexibility. (Cooper 2015) Also seeking ideas from outside of the company with an open innovation is one approach that will be introduced next.

2.2 Open innovation

Internal R&D also called closed innovation has been recognized to be internal asset and a competitive advantage but now that the competition between companies has increased, technology is developing fast and the amount of newer companies coming to the market, there is not enough time and knowledge to develop ideas only internally. For internal

R&D company needs significant resources and investments. Companies are moving towards open innovation where innovating happens also externally with customers, partners and suppliers (Chesbrough 2003, p. 32-35). One important factor for companies moving to open innovation is time-to-market which determines when the new product needs to be ready and when the new product development project should end. This means that the scheduling of the project is done backwards from the end day to starting date. This usually means that the project has really tight schedule and there is no time and resources to develop everything inside of the company. (Rakitin 1999, p. 54)

Open innovation means that companies start looking for knowledge outside of the company and not try to develop everything by themselves internally but not giving up the internal R&D either. Open innovation is adding external resources and knowledge to company's own internal knowledge and resources and by combining these two when developing new products and capturing the value from them. Companies should for example help to fund young start-ups and explore the future opportunities from them in order to benefit in their own R&D strategy (Chesbrough 2003, 49-53). Ili's study (2010) shows that open innovation proves to be more efficient for companies to achieve better R&D productivity in the automotive industry than closed innovation. Open innovation includes following activities: seeking opportunities, recruiting potential partners, value-capturing through commercialization and extending the innovation offering (Grönlund et al. 2010, p. 108).

It has become more relevant for companies to ask the question how to innovate than why to innovate. A recent trend has shown that companies can get more resources to innovate from outside of the company by building relationships with other companies. Logic behind the open innovation is to use internal and external ideas to find the opportunities to maximize the returns from the new product development. (Grönlund et al. 2010, 106) Other thing behind open innovation is the purpose of being productive which in this case means being able to innovate effectively. According to Goldman (2005) high productivity means taking advantage of the effort of others and not only company's internal resources. This means that company needs to recognize the talent and valuable work of other companies and find a way to utilize that while maintaining a competitive advantage.

Open innovation requires different way of thinking from the company's employees by seeking also external opportunities and sharing their own internal ideas with external partner. This can be difficult. Already internally companies struggle with information sharing so taking a partner and starting to share information with them can be very challenging and for that also technological systems need to change so that companies can share more easily information between each other. (Grönlund et al. 2010; Ili et al. 2010) Open innovation can also been seen as a risk management asset when companies can divide the cost and risks of new product development and both parties get the benefit from the success. The challenging part is to define what needs to be owned, what can be developed with partners, how to share information, who owns the intellectual property rights and how to

control activities done by external partner or supplier. At the end the target is to meet customer needs with combining internal and external resources. (Witzeman et al. 2006, p. 19 - 22)

For open innovation companies need to seek innovations also outside of the company. This means that after identifying an innovation there are different methodologies and organizational structures for sourcing external technology and getting the external technology to their own product or process which are introduced next.

2.2.1 External Technology Sourcing

Based on the research of Witzeman et al. (2006) there are four different methodologies and organizational structures for sourcing external technology and getting the external technology to their own product or process. Used level depends on the nature of the business, current industrial position, future business intent or different projects. Input for choosing specific level comes from the nature of company's business, internal research capabilities and level of resources in a project. Different levels are: Cost and Supply Chain Management, Strategic Partnering, Extended External Networks and Integrated external innovation.

In level one and two the idea or need already exists and company is seeking some specific knowledge or technology. When targeting on sharing costs in new product development project the main level used is Cost and Supply Chain management approach. With it the company can achieve cost control by combining internal resources with external key suppliers' resources. This approach is often used to modify and develop new products when creating something completely new. Difficulty in this approach is that the key supplier can share the developed knowledge or technology with competitors so advantage is short-term. Also managing the external supplier is difficult and demands a different process from the company. To get better protection for the developed technology the next level is strategic partnering with customers, institutions and key suppliers. This level is more used in longer time period because it demands more effort from both companies and more information sharing. The purpose of this approach is to meet specific market needs or to get better access to supplier's development skills. The result of this approach is new product or service offering with hopefully longer competitive advantage which will benefit both companies. (Witzeman et al 2006, p. 24)

In level three and four the main focus is developing ideas with specific knowledge or technology. The key supplier is involved from the beginning and innovating with the company. This means more complex processes and higher levels of infrastructure when multiple partnerships occur. The most advanced level is Integrated external innovation which means integrating supplier's processes and knowledge to the company's processes. It is driven more by long-term strategy but also meeting short-term needs. The goal for the company and the supplier needs to be well aligned and defined for long-term which

means that company needs to select these highly strategic partners well before integrating them. Mistake in the supplier selection might be costly and the selected supplier difficult to change. In these approaches the information technology is used to manage the external innovations and share information between the companies. (Witzeman et al 2006, p. 25 - 26)

After deciding on how to source external technology it is important to be able to integrate the selected supplier into the NPD process. This helps to achieve the targets for the project and work more structured way when the process is already defining how the supplier is included in the project. Next chapter goes through this supplier integration into the State-Gate model.

2.3 Integrating the supplier into the State-Gate model

As important as it is to get the supplier involved in the project researchers have found out that the process of integrating the supplier is lacking structure (Corswant & Tunalv 2002). One way of integration is to follow the early supplier involvement (ESI) concept. This will be covered in more detail in the chapter 3.6.1. Having suppliers involved early in the project doesn't help if there is no defined structure for the NPD process where suppliers are integrated in the process. Companies have started to combine the State-Gate model with open innovation to get the benefits of open innovation and minimize risk with defined structure. To create an open the State-Gate process companies need to keep the boundaries of the State-Gate model open for external suppliers or partners to be able to exchange information and know-how in each stage of the project. Companies need to also add additional activities into their process for different stages including internal and external activities that needs to be done with the supplier. Internal activities with supplier means in this case for example supplier selection for the project and external for example supplier's project management activities. The company owning the project needs to make sure that these external activities are also done on time in order to finish the project on time. Other difference to the normal the State-Gate model is that in open the State-Gate model the project evaluation criteria in the gates needs to be modified better to respond to the need of evaluating also the supplier's readiness. When preparing the gate deliverables searching for opportunities to share and receive knowledge becomes a critical task for NPD project team so that the gatekeepers have all the relevant information related to the project before approving the project to move to the next stage. (Grönlund et al. 2010, p. 117 - 125)

Companies are looking for ways to cut the lead time of the new product development projects, improve quality, reduce the cost of new product and ensure the smooth launch of new products. To achieve these goals companies have started to integrate the suppliers into the new product development process. The level of integration depends on the criticality of the supplier for that project so some suppliers are involved only for basic pur-

chasing and some can be more involved designing and manufacturing of the product (Petersen et al. 2005; Ragatz 2002; Corswant & Tunalv 2002). Also different suppliers are involved in the process in different phases and some suppliers can be involved already in the beginning as an ESI supplier.

Implementing open innovation in a global innovation-driven company can be hard and will have some challenges. Open innovation demands information and knowledge sharing to be successful so the company has to have an open innovation mind-set to be able to work openly with suppliers (Nakagaki et al. 2012, p. 32 - 36). Also study of Ragatz, Handfield and Petersen (2002) shows that the important things that support achieving the project targets (time, quality and cost) are effective alignment of the company and supplier, technology sharing and that the supplier needs to be part of the project team. For this to be able happen project managers needs to establish an open relationship with the supplier, understand the supplier's processes and technology and make sure that the supplier is fully accepted into the project team and receiving all the information needed. Leading companies have recognized the power of networks in creating new products and services. They are getting close to the customer wanting to understand the real needs, working together with suppliers and building a wide network in order to deliver innovative solutions. (Slack et al. 2013 p. 300)

2.4 Capturing the value from the project

After the projects finishes it is important to capture the value from the project. The value of the project doesn't mean only intellectual property rights or first-mover advantages. The value can be increasing the level of knowledge in the company from learnings from the project, increased performance which shows then in better ways of meeting customer needs and also economic growth by upgrading processes or capabilities. Sustainability is one critical factor and it can mean for example cleaner products or more efficient processes. (Tidd & Bessant 2013, p. 567 - 606)

Capturing the value from the project is important because the company has invested a lot of effort and money into the project. The success of the project doesn't only mean how valuable and selling the outcome is but also capturing learnings and best practises for the future use is vital. Of course the goal of the product development project is to produce a product that meets its specification. Defined way of managing the NPD project will minimize risks and help to better capture the value when there is a defined channel for learnings and control of monitoring the progress towards the targets. Continuous development in new product development is critical for the company to be able to keep producing new products with higher quality demands, shorter life-cycles and shorter time-to-market. These combined with fast technology development demand a fast new product development process which demands continuous learnings and improvements. Without it the company will suffer from the lack of competitiveness. Innovation is the key of getting bigger market shares and beating competitors in the markets.

Structured way of implementing a new product idea is better for measuring and monitoring the project. Different stages and phases concentrate the focus on relevant tasks and keep the project better under the control by having gates to review the project in shorter periods. Controlled project helps to better measure then success of the outcome and to capture learnings and best practises but to have a good control the companies need to combine a good structure process with good project management. The next chapter focuses on project management and supplier project management in order to achieve the project targets.

3. SUPPLIER OPERATIONS PROJECT MANAGEMENT

3.1 Project Management

The researchers are arguing if the buyer can benefit from involving a supplier into new product development process by achieving better product quality, shorter development time and reduced product and development cost or if this involvement is only increasing cost and lead time of the project (Ragatz et al. 2002; Takeishi 2001; Petersen et al. 2005; Wynstra et al., 2001). The reality is beside all the arguments favouring and arguing against the supplier involvement in a development projects that suppliers are becoming more and more involved since the demand from the markets is higher (Lawson et al. 2015). With high quality expectations combined with technology development and shorter time-to-market there is a clear need to involve the suppliers with specific knowledge and skills into the project. The level of involvement can vary from giving advice to designing a whole product and manufacturing it (Wystra & Pierick 2000; Wasti & Liker 1999, Flies & Becker 2006).

Companies need to produce new products faster and with high quality which means that there is not so much time to develop all the needed knowledge and skills inside the company. It is faster to get the skills and knowledge from capable supplier and also cheaper when there are necessarily no investments needed. This leads to a problem of how to make sure that the supplier is motivated enough and skilled enough to be involved with this specific project. In such situations where the supplier is lacking of technological or product development capabilities the company might actively start developing the supplier and its capabilities. But how to make sure that the company is selecting the right supplier and how to ensure a good level of performance from the selected supplier? One main contributes of developing or using the supplier's new product development capabilities is to integrate supplier into the NPD process in order to the benefit from the supplier's knowledge, technology and various skills. Supplier has to have abilities to provide technical and production expertise and in NPD project to move quickly from prototype to even high volume production and at the same time manage their own supply chain and on time delivery with high quality.

This chapter goes through the basic theory of project management, the importance of the supplier selection, supplier development and involvement in new product development process. The following sections go through project management life cycle and objectives without forgetting the method of critical path in projects.

3.2 Project Management life-cycle

Project management model is a tool to help to see the big picture in the beginning of the project. It has five stages, each of them presenting different areas in a project. Stage one starts with understanding the environment of the project both internal and external. Project Manager needs to understand different internal and external threats and opportunities that might have an effect to the project. Stage two concentrates on the defining the project. This part needs to be done carefully since the company defines the scope of the project, goals and strategy. Stage three is the planning phase of the project where deadlines and plans how the project will be executed are decided. Stage four concentrates on performing the technical execution of the individual project. Stage five is the project control which is important because while defining the earlier stages usually there will be some changes for example in a project scope or in technical execution so changes need to be controlled to support that the outcome of the project will be what is expected. (Slack et al. 2013, p. 501 - 512) The figure 3. shows the project management model.

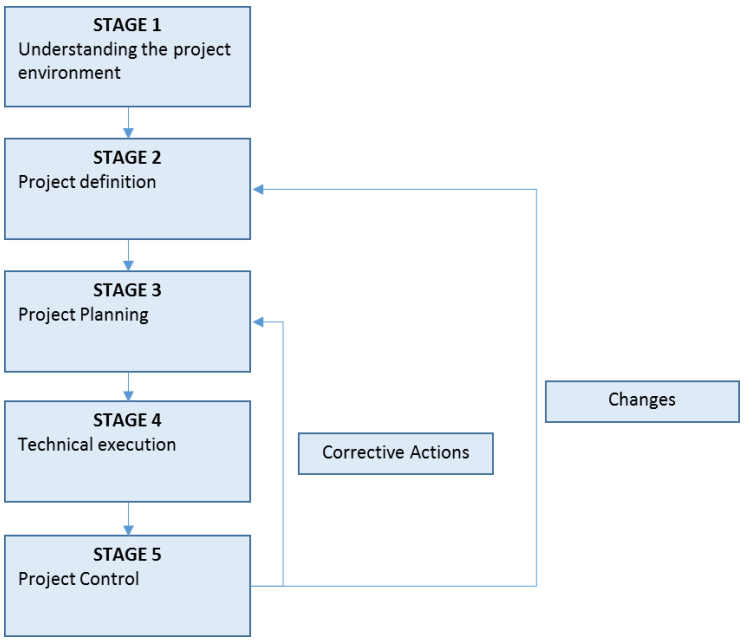

Figure 3. The project management model (Slack et al. 2013, p. 500)

All the stages suggest to do risk assessment during the project lifetime. All the factors that may affect to the project need to be considered in a stage one. Those factors might be internal or external and by understanding them company can define the way how the project should be managed and also analyze the risks that may cause the project to fail. Before starting the planning stage of the project it is important to know what the project really is and what is expected. (Slack et al. 2013, p. 504)

Project manager needs to define together with stakeholders the project success criteria as a part of project management plan. The project success criteria are the most important objectives that needs to be met to enable the project to be defined as a successful (Lester, A. 2014, p. 38). The next chapter introduces the defined criteria that measures the success of the project and how the criteria may vary depending on the project.

3.3 Project objectives

The Iron Triangle was introduced already Oisen RP (1971). It defines three criteria that measures the success of the project. These are quality, time and cost as shown in the figure 4. These criteria have been used when determining the definition of project management (Atkinson, R. 1999). Other articles published support also the success criteria Oisen suggested but allowing the use of temporary criteria during the delivery stage to help monitoring that the project is going accordingly the plan (Wateridge, J. 1998; Chua et al. 1999). Some researchers like Wright (1997) suggests that only time and budget are the most important. He argues that his view is more from the customer side assuming that projects will be completed more or less according to the specifications. Slack (2013) follows the three objectives of the Iron Triangle but combines time to include speed and dependability. Mohammed and Lim (1999) added two criteria more: performance and safety. Other additional success criteria can be sustainability, reliability, legacy, and meeting the desired business benefits (Lester, A. 2014, p. 38).

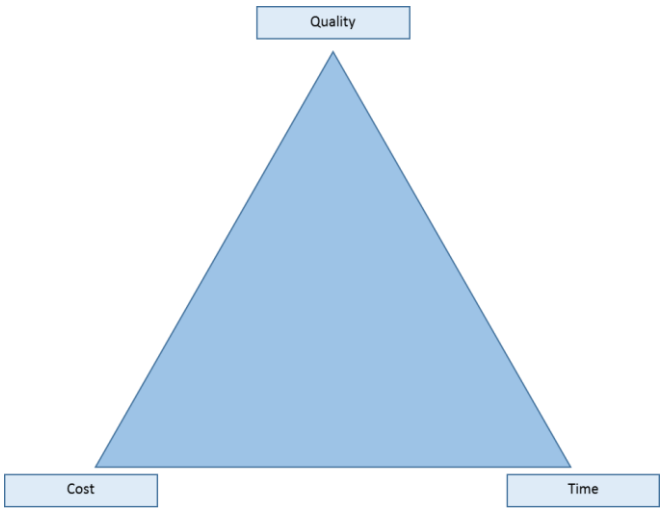

Figure 4. *The project objectives triangle (Slack et al. 2013, p. 504)*

The criteria are supposed to help to determine the project objectives which in the end help to monitor progress and the direction of the project ensuring that the project is going to the right direction and the outcome is what is expected. The importance of each objective varies in different projects. (Slack et al. 2013, p. 504) Some projects have more weight in quality and others have very strict budget so the cost of the project is not allowed to increase. Although it has also been argued that if all the three criteria should always have the same weight (Chua et al. 1999, p. 148).

Objectives can be also something else than these three depending on the project but when measuring the performance, it is relevant to keep the objectives measured as clear and simple as possible so that they are measurable and easy to understand (Slack et al. 2013, p. 504). Achieving the project targets means that the path of the project needs to be known and defined so that measuring of the process is possible. Defining the path is done with a method called critical path method and this is covered in the next chapter.

3.4 Critical path method

The critical path method defines the longest sequence of tasks in a project plan that are critical to complete on time in order for the project to meet its time target. Critical tasks are defined to be those tasks that must be completed in order to finish the project. If there are any delays on those critical tasks the whole project will be delayed. This method is breaking the project into tasks level, displays them in a flow chart and based on the flow chart calculates the project duration based on the estimated duration of each tasks and the relationship between them (William East, 2015). As projects are becoming more complex it is critical to identify the relationships between different activities. The critical path method is used to show the order and the relationship between tasks. A project may contain a lot of different tasks but evaluating the criticality will show that not all of them are critical for the project's success. This method starts with taking one task and evaluating its criticality and if some other task needs to be completed before this task can be started it means that these tasks have a relationship. One task can't be completed without the other. (Slack et al. 2013, 514 – 516)

Critical path becomes highly critical in a project which consists cross-functional teams and where different teams have tasks that has relationships. Time is also usually against the team and everything needs to be done fast. Understanding the tasks needed and their duration helps to calculate what is the lead time of the whole project. Failing to understand the critical path of the project and the relationships between activities may increase the risk of the project being delayed since team member can't proceed while waiting another team member to finish their task. The next chapter highlights the importance of the risk management in the project related to quality, time and cost.

3.5 Project risk management: quality, time and cost

As mentioned in the chapter 3.3 the project objectives are the ones that are measured during the project and which are evaluated after the project has ended. The main objectives are critical for the project's success. Identifying the risk related to quality, time and cost factors is important. There is number of tools used to identify and manage the risks.

Taking these tools into the practise requires time and effort both personal and organizational level to learn and understand the purpose of the tools but the cost of implementing these tools needs to be beneficial. (Raz & Michael 2001 p. 10)

The product or service quality of new product development starts by defining what are the quality expectations of a customer and what are the factors that are critical for the customer. Customer can be internal or external or maybe a future customer who doesn't know exactly what he or she wants. For the project we need to have an idea of what is the voice of customer (VOC) which means that the needs and expectations of the customer are defined. From VOC project team can define what are the critical factors to the product under development that have an influence for the outcome of the project and these are called Critical to Quality factors (CtQ). It is important to choose only the really critical ones and concentrate on them. Critical to quality as mentioned above can be also defined for the project. Project team should define what are the most critical factors for the project and project quality in a higher level. This helps to direct the resources to the right things and gives the team the idea what to do next and what needs to be concentrated more. Project teams are usually lacking resources what makes them concentrate more on the important parts but what happens if there is nothing defined? Maybe they all concentrate on different things that they think are the most important ones. This creates a bit of a chaos. This is why there should be clearly defined critical factors for this specific project. The input for critical to quality comes from the voice of customer but also from the project's risk assessment. As an outcome there is more clear path of what needs to be done in order to achieve the project's goals and expectations. (APQP Manual 2008)

Before completely defining quality targets the project team needs to also consider what is the time to market for the product under development. This defines when the project needs to be ready. When the end date of the project is given first it means that scheduling needs to be done backwards. This usually results failures with poor quality. " When making the time-to-market vs. quality tradeoff, more often than not, quality suffers." (Rakitin, S. 1999, p. 55-57) When planning with the time available rather than time required for the project the project team needs to avoid surprises. They will not have extra time nor resources for unexpected occurrences which might cause the project to be delayed.

Cost as a risk factor starts to show in reality when the project starts to have delays. Time is money and keeping the limited resources engaged with the delayed project may affect then other projects or even daily work. Other thing showing as a risk for cost is quality which can be design quality, process quality or service quality. Designing a nice product can't always be possible when you start thinking about the manufacturability (Anderson 2004). Corrective actions involve time and resources which are increasing the cost of the project.

Quality, time and cost are the three main things companies measure in the project and they are all affecting to each other (Slack et al. 2013, p. 504). The challenge is to find the

balance between these factors. Sometimes better quality in the beginning is worth of small delays and cost increase when it in the end is cheaper than designing something really quickly and doing a lot of corrective actions then afterwards. Next chapter concentrates on leading supplier in the NPD project in order to achieve the project objectives.

3.6 Leading supplier's performance in a NPD project

The research of Takeishi argues that "outsourcing does not work effectively without extensive internal effort. To gain competitive advantage from outsourcing managers should not ask what your suppliers can do for you; ask what you can do with your suppliers." The three factors affecting to the outcome of NPD project when working with the supplier are problem-solving, communication and knowledge level. The company should have a problem-solving process with the supplier already in early phase of NPD, frequent communication and open information sharing. (Takeishi 2001) Keeping in mind that even though collaborating with the supplier, the company needs to develop its own internal capabilities also in order to outperform its competitors.

When leading a supplier in a NPD project it is important to have both strategic management and operational management areas. The strategic contains processes that give the direction for long-term and helps for example in the selection of a supplier. Operational contains processes that support the project team to involve the supplier into the NPD project. (Van Echtelt et al. 2008) Other critical factor in order to be able to lead the supplier in the project is to involve the supplier into determination of metrics and targets for the project. Jointly created targets and metrics will affect in project team effectiveness. This is highly critical when the supplier has a bigger role in the project and high level of responsibilities. (Petersen et al. 2005; Ragatz 2002) Hartley, Zirger, & Kamath (1997) study shows that even strong management of low performing or low motivated supplier doesn't affect to the supplier's performance and doesn't reduce supplier related delays. Instead selecting a supplier with strong technical capabilities and commitment has better results on reducing delays related to the supplier. Including the supplier in NPD project team and coordinating communication and information sharing between the members of the team will help to identify potential problems, prevent those problems to appear, reduce delays and ensure that the project is completed on time with expected quality (Wasti & Liker 2006). The result in a case study done in auto industry shows that even though suppliers were encouraged to act pro-actively and even they tried to act that way the performance was low and company needed to intervene and help suppliers to solve problems (Conrswant & Tunalv 2002). This shows that the performance is heavily dependent on the company's role in the relationship.

Implementing an open innovation concept in a global innovation-driven company can be hard and will have some challenges. Open innovation demands information and knowledge sharing to be successful so the company has to have an open innovation mindset to be able to work openly with suppliers (Nakagaki et al. 2012, 32 - 36). Also study

of Ragatz, Handfield and Petersen (2002) shows that the important things that support achieving the project targets (time, quality and cost) are effective alignment of the company and supplier, technology sharing and that the supplier being part of the project team. For this to be able to happen project managers need to establish an open relationship with the supplier, understand the supplier's processes and technology and make sure that the supplier is fully accepted into the project team and receiving all the information needed. Project managers who are looking to reduce lead time of the NPD project while increasing quality should concentrate on proper integration of the supplier. Making supplier part of the NPD team meetings helps to achieve these targets. (Ragatz et al. 2002)

When integrating a supplier into new product development process it is critical to select the right supplier for the project since it might later on have an impact on how the interaction between the company and supplier is going to be. Other success factor influencing to the supplier involved is early involvement in NPD project. It is critical in order to achieve a good relationship and integration for the supplier to identify the expectations and targets of the project and accept responsibilities related to development, design, manufacture, delivery, quality and the responsibility of integration and communication (Wagner & Hoegl, 2005). Next sections cover the topics of early involvement, supplier selection and the role of supplier development in NPD project which can all affect in achieving the targets of the project.

3.6.1 Early supplier involvement

Already Heide and John (1990) in their research stated that close cooperation between the company and its suppliers will lead to better outcomes for both parties. It has shown that 80 % of the manufacturing cost of a new product is defined with the design of the product. With this there are opportunities to save money by integrating the product design and the supply chain (Ernst & Kamrad, 2000; Mikkola & Skjoett-Larsen, 2003). Supplier involvement in NPD projects is essential because suppliers have specialized technology or capabilities that the company can get from them to the project which is critical when the customer needs are getting more complex and therefore companies need to create complex products fast and low cost. Sourcing external technology to meet customer needs by combining internal resources with the selected external resources means that suppliers are more involved with the development process of innovating new products. (Witzeman et al. 2006, p. 22)

Early supplier involvement (ESI) is defined as a vertical cooperation where manufacturer involves suppliers in the early stage of the product development or already in the idea phase. This means that supplier is part of the team creating the product and designing it. (Bidault et al. 1998) Being part of this phase gives the supplier more possibilities to influence on the design of the product. By involving the supplier, the company can access the technology and knowledge of the supplier more easily and get ideas from the supplier who may have better understanding of the specific area. For the company early supplier

involvement is a way to have a shorter product development cycle time, improve quality and reduce costs of the development when everything does not need to be developed inside and company can use already existing technology of the supplier. (Lyu et al. 2010; Song & Di Benetto, 2008; Van Echtelt et al. 2008)

ESI includes also difficulties which can destroy the possible benefits of working together. Most common difficulties are lack of information sharing and lack of effectiveness which are causing delays in a project schedule and increasing costs. This is mainly due to an uncooperative attitudes and low priority given to a specific supplier (Primo & Amundson, 2002) When clear strategic priorities are set, the benefits of ESI are achievable (Bidault et al. 1998).

A company should manage the business activities both in-house and by outsourcing and make decisions to buy or manufacture based on evaluating its own capabilities and potential choices for suppliers (Barney, 1999). Early supplier involvement is very critical for coordination of the process in supply chain design, product design and process design (Petersen, 2004, p. 371). Also a case study shows that companies are involving more and more suppliers in their NPD activities and delegating more NPD responsibilities to their suppliers through co-development (Mikkola & Skjoett-Larsen, 2003).

The findings in the research suggest that company adopting ESI should have mutual strategy defined with the supplier. For both it should be clear what is the goal and how to get there. Clarification also minimizes the risks involved and keeps the project in schedule when everyone knows what to do and when. After defined strategy company and suppliers need to be committed to that strategy in order to benefit from ESI. (McIvor & Humphreys 2004, 198)

Early supplier involvement demands a good relationship between the company and the supplier. Mutual goals and benefits helps to create a desired level of commitment from both sides but the capabilities of the supplier need to be evaluated. This leads us to the next topic which is the importance of the supplier selection.

3.6.2 The importance of supplier selection

The research shows that selecting a good supplier for the project and setting mutual goals and targets can improve the NPD team effectiveness which has been proven to improve both financial performance and design performance (Petersen et al. 2005, p. 381 – 385). Supplier selection is a strategic decision and selecting a low performing supplier might end up costing money and affecting delays for the project. This is why companies should invest time and effort when selecting suppliers. Of course the importance of the selection in NPD project depends on the role of the supplier and what is the need that the company is trying to fulfil with that supplier. These factors affect the level of involvement of the supplier. Strategic parts of the project need a good performing supplier since those have

high quality expectations and delivery requirements than compared to for example bulk products. Also in same cases the supplier might have some technological advantage which will benefit the company and in this case the supplier would become more as a partner for longer term.

Companies manufacturing high technology products purchase materials and services even up to 80% of the total product cost. This increases the criticality of supplier selection to be one of the key elements of finding opportunities and reducing costs. Traditional approach of supplier selection has been based on the price but now companies have learned to use multi-criteria decision making techniques.

Selection criteria supports the critical task of supplier selection. Supplier selection studies use a wide range of criteria: quality, price, delivery compliance, service, and technological knowledge (Kumar & Ashis, 2014). Also environmental, social, political and customer satisfaction concerns are added to the criteria. Companies are working continuously with their suppliers to remain competitive by reducing product development time, improving product quality, reducing lead times and achieving greater innovation. By selecting a supplier with single criteria makes the selection highly risky. Knowing the supplier after the multi-criteria based evaluation minimizes the risk. (Zeydan et al. 2011, p. 2741 - 2751)

The company should have criteria defined for supplier evaluation. It is important to evaluate the capabilities of the supplier in order to evaluate how the supplier is going to perform and what are the risks of selecting this supplier. Other factor influencing the success of selecting a good supplier is the culture of the supplier because the culture will tell the ability to interact with the company. The success in integrating the supplier into NPD projects is highly depending on the company choosing the right supplier for the project.

In NPD projects the level of supplier integration depends on the criticality of the supplier. Evaluating each supplier for the project is important but the level of evaluation and time used for getting to know the supplier and processes differs based on the criticality of the supplier for the project. After selecting the supplier for the project, the next step is to define which are the risks and development needs in order to meet the targets of the project with lower risk level and better support from supplier's side.

3.6.3 The role of supplier development

As mentioned in the chapter 3.6 the company should have concentrated on what it can do with the supplier and not only what the supplier can do for the company. Suppliers are getting increasingly central role in achieving the new product development targets that companies have set to themselves. The role of the supplier development is to manage the quality of the supplier, introduce the supplier with company's NPD process and targets

and also help the supplier to improve its performance (Lawson et al. 2015, Wagner & Krause 2009).

Supplier development in NPD process concentrates too often to reactive supplier development approach which means that the company starts developing the supplier after the production has started and the problems in supplier's performance have been found out. Reactive approach is always too late and can't prevent any problems. Instead the company should evaluate the supplier's capabilities and think proactively about how to improve them to solve problems that frequently might occur in NPD process. (Koufteros et al., 2010; Rauniar et al., 2008; Lawson et al. 2015)

Clear strategy and commitment are key points to achieve benefits from supplier development. It is really critical that both the company and the supplier identify the set of skills, behaviors and attitudes that need to be developed in order to support effective collaboration. This development goes into individual level and improving the performance of the individual the whole team starts to perform better. (McIvor & Humphreys 2004, 198*)* What Lawson et al. study shows is that the important factor in improving the performance of NPD is to develop supplier's creative and innovative capabilities (Lawson et al. 2015).

As a summary the vital parts in NPD projects with the suppliers are to have a structured process to manage the project, have defined targets for the project and a clear scope, have an open communication and good collaboration between the company and the supplier and a good leadership in the project. With a supplier it is important to evaluate them first, select the suitable for the company and for the project and based on the evaluation reactively develop the supplier and prevent possible future problems. To run a good SOPM part in a project needs strong project management and leadership skills and carefully selected suppliers in order to avoid problems and delays later on the project. The key for good project management is to define the scope and plan. Without good planning it is very hard to communicate to the project team and the supplier what is wanted and when and it becomes a mess. Resources are valuable so better use them for value-adding work that keeps the project moving towards the targets. Next chapter goes through the methodology of the thesis work to better understand the methods used.

4. METHODOLOGY

Case study method is used to understand the how and why of the events, situations or problems without necessarily having any control over those events or problems. The method is designed to illustrate the decisions taken: why the decision was taken, how it was implemented and what was the result. A case is defined to be an activity, problem or event. A good case is usually taken from real life and it presents both good and bad practices as well as failures and success. Facts must not be changed but analytical thinking of how these kind of situations can be handled combined with critical thinking is preferred. (Yin, 2003)

For this thesis the methodology is case study. In the thesis we study the theory behind new product development and supplier project management and using that gathered knowledge we develop practical tools to support the problematics of product development when involving suppliers. The main focus is to see the reality and how the case company is using the theory behind their processes and tool development. This real-life context gives deepness for the thesis and practical view for the theory. Thesis consist a lot of how and why questions during the tool development. It takes the theory and best practice knowledge from experienced professionals and combines these two to reality for daily work.

Case study methodology's purpose is to illustrate the specific topics within an evolution. In this case the development of the State-gate model to better involve also the external suppliers. The case study has research design where the purpose is to set questions in the beginning and answer to those questions with a set of conclusions. For research design it is necessary to have four conditions: Construct validity, Internal Validity, External Validity and Reliability. (Yin, 2003) This thesis is single – case study since the thesis has only one case company under evaluation. The circumstances are unique in this case since every company has different combination of NPD processes, culture and capabilities and knowledge of the employees. The amount of suppliers used in a project is increasing which also creates unique situations where the new tools are tested. The theory behind project management and new product development is well formulated. In this case the thesis was part of creating something completely new for the company but automotive procedures were used for benchmarking.

The role of theory is essential when setting the questions and implementing the theory in reality. It also helps to generalize the case study back into theory when the learning from the practice can be transferred to theory. Theory is built based on the questions asked in the beginning and the target is to answer for those questions in the conclusions part by combining the theory and results. Research design prefers analytical generalization rather than statistical generalization (Yin, 2003).

5. RESULTS

5.1 Process development

The case company as described in the beginning in the introduction already had a process description of their new product development. The process was created based on the State-Gate Model which is described in the chapter 2.1.1. The case company operates with continuous improvement and noticed that the current process needed to be updated and the lead time of a new product development process needed to be shortened without failing to achieve the required quality target. The process description was lacking deeper insight of how to lead suppliers involved in a project. The old version of product development process was kept as a base for the new process and benchmarking with lessons learned were used to review what needed to be updated. As mentioned in a chapter 2.1 suppliers are going to be more involved in NPD projects than before due to a shorter time-to-market and demands of high quality combined with fast technology development. The new version goes into detail on how to lead a supplier in a NPD project and how to involve the supplier better into the project. The process is an outcome of inputs from the knowledge of highly experienced people and benchmarking. For the thesis work the process development part was to go through the new process and define which tools needed to be developed to support the process and daily work of supplier operations project managers who are responsible of the suppliers' performance and right involvement in a NPD project. The goal for the process description in this thesis was to make it easily understood so that all participants involved in NPD projects could understand what, how and why to do required activities and who has the main responsibility.

The case company was benchmarking the leaders of auto industry and its main partners and how the auto industry is doing supplier integration and decided to do it in a more detailed level in order to cut the lead time of the projects and ensure the quality level to stay stable through the project. The main difference between the old process and new process is that the responsibilities of each team member is more clearly shared and each member of the project team has their own team supporting the execution of the tasks. The whole project team consist of 7 members that represent the main contributors in NPD project. One of the members is called Supplier Operations Project Manager (SOPM) who is responsible of leading supplier, sourcing and supplier quality management activities in the project. SOPM is also responsible of the integration of the supplier and leading the supplier in order to follow that the supplier is taking the responsibility of the execution of the supplier's tasks on time and with right quality.

The process is built by using the State-Gate model and modifying it to better meet the requirements of the case company. The whole process is divided to six parts which are

separated from each other by gates. Every part includes specific activities to be taken before the project team can look for the go – decision to move the project to the next part and towards the next gate. In the process the responsibilities of the supplier are also described in detail. The actual SOPM process is descripted in five levels where every level goes into more detail. Phase is the level one showing different gates and project phases in very high level. It determines which are the different project phases in NPCI project. Groups in level two are defining the topic groups that are included to the process: Project Management, Sourcing, Quality, Manufacturing and Process Part Approval Process (PPAP). Must have is the third level presenting a structured way of what needs to be included always in every project. It shows also the critical path of the process as described in the chapter 3.4. Not every step is highly critical for the project success so in order to highlight the most important ones the company created a must have level for the projects. Steps and Deliverables/ Activities in the lowest two levels go very deeply into the process defining what, why and how a specific activity should be done, who is responsible and what is the order of the deliverables / activities and what are the dependencies between the different steps.

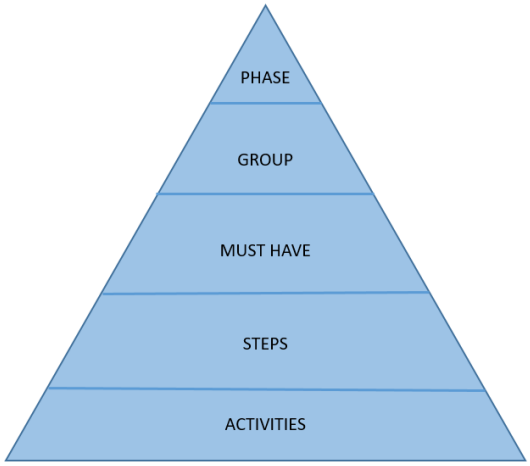

Figure 5. *The different levels in SOPM model*

As criticized in the State-Gate Model the defined structure might make it too slow for the NPD projects since it adds bureaucracy. To make the process more flexible and to reduce waste the process of the case company can be modified for every project by removing the activities needed if for example the lead time of the project is short there is no time to do every activity. Also suppliers that the case company will use in a NPCI – projects will have a different level of knowledge of the company and its quality requirements. For example, suppliers that are already suppliers of the case company have the basic knowledge of quality tools used which means that there is no need to train the suppliers to use them anymore since the training has been given already and they have been working together before. This compared to the completely a new supplier which will need more time to go through trainings and development work. The steps selected are also depending on how deeply the supplier is involved in the NPD project and how critical is

the role of the supplier for the success of the project. The way the process was created gives an opportunity for each Supplier Operations Project Manager to select for each supplier the process steps needed. Only limit is that Must Have steps need to be included always as mentioned already before as shown in the Figure 6. In Figure 6 is shown couple of must haves as an example what they could be in different areas and different stage of the project.

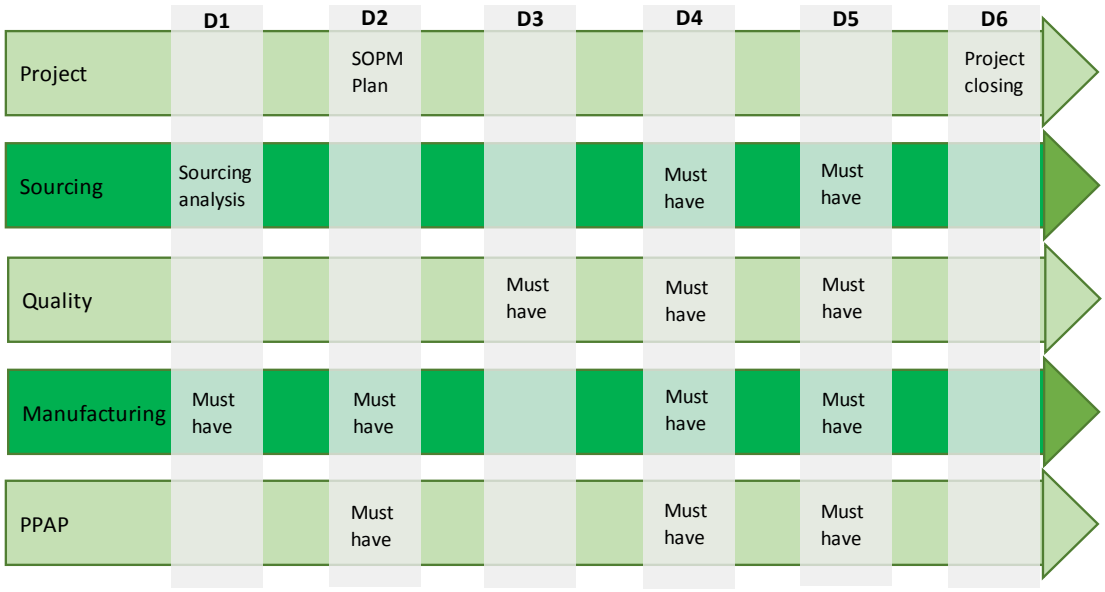

Figure 6. *Example of must have review as critical path*

Other thing that was noticed to be a problem was how to include supplier better into the project as mentioned already before. The theory of open innovation together with ESI are supporting the idea of including the supplier into the project team. In the case company supplier was defined to be part of the Extended Team where the project manager is SOPM who is also a project Core Team member. This will help to keep suppliers involved in the project and ensuring the right resources for the projects. Figure 7. is showing an example how the core team and extended teams are formed. The most critical members in Extended team are SOPM, supplier quality engineer, sourcing, supplier's project manager and supplier's quality manager. The teams can be changing depending on the criticality and size of the project. The SOPM matrix is a tool between SOPM and supplier. SOPM is leading both the company's internal processes related to the suppliers and external suppliers in the project.

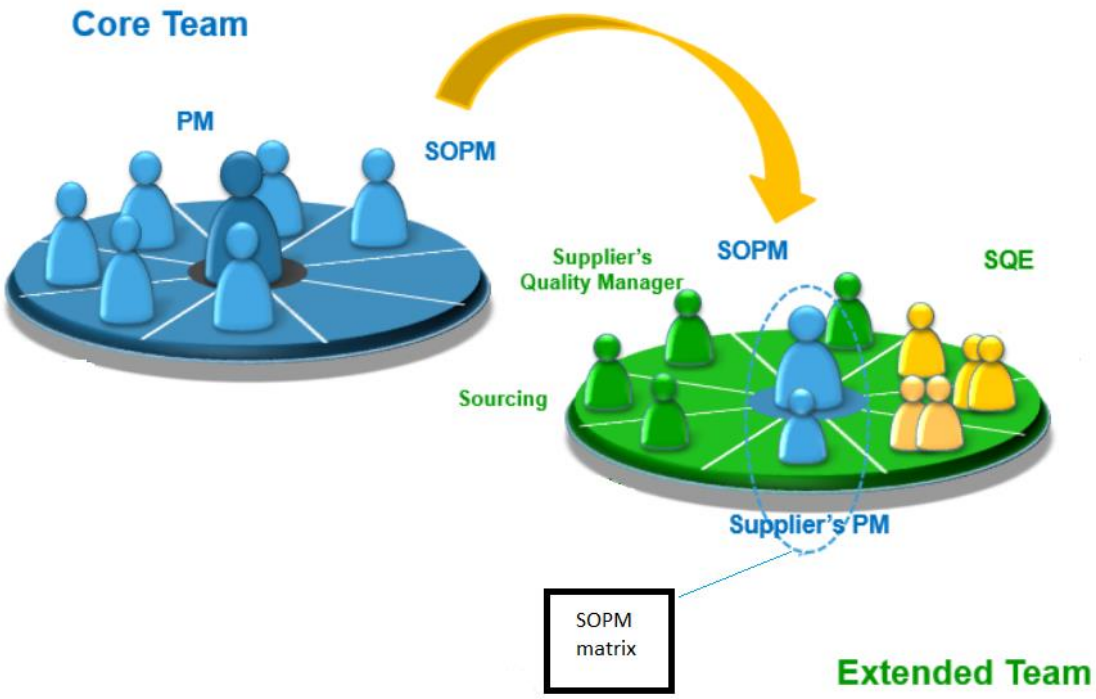

Figure 7. *Example of the structure of core team and extended team*

As Echtelt (et al. 2008) mentioned the strategic management is important to have when for example selecting suppliers. Created process gives a guideline what needs to be validated when selecting suppliers and who are participating to the validation. By having a team, it is not only sourcing person's work to select the supplier but also supplier quality engineer is participating for the selection and by doing that the company can ensure a good validation process before taking suppliers into the NPD project. Other important management area is operational which supports the project team to involve the supplier into the NPD project. By having SOPM is a member of the core team ensures that the planning needs to be executed with the supplier and the targets needs to be defined also with the supplier. One example of SOPM task that involves close cooperation with the supplier is creating a SOPM plan that defines the schedule and tasks based on the stage that the project is. SOPM Plan is just an example from many other deliverables that have supplier in those. Figure 8. shows as an example the SOPM Plan deliverable.

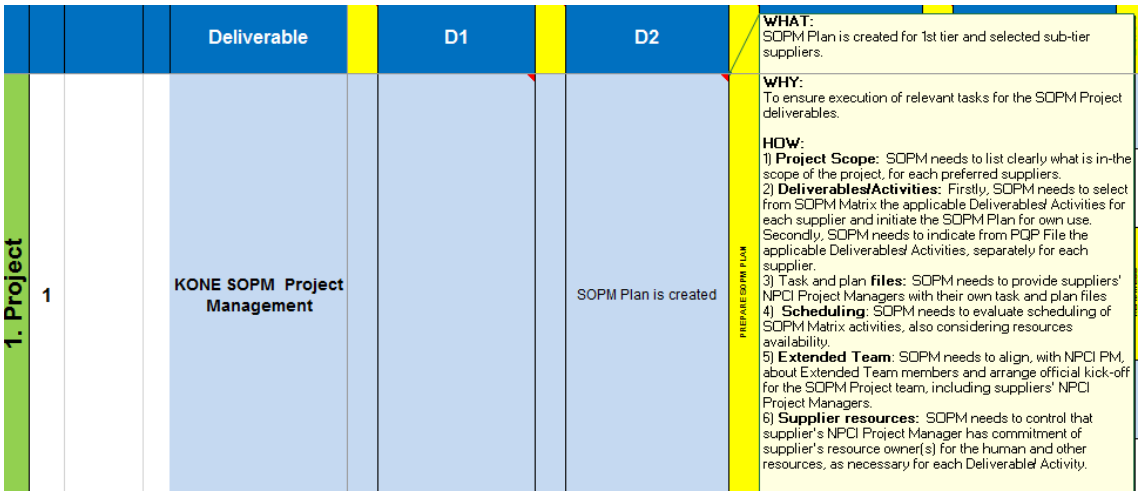

Figure 8. *Example of SOPM Plan deliverable in the matrix*

After process development it is necessary to have tools to support the execution of the project. These tools were created based on the needs coming from the matrix. Next chapter 5.2 introduces the tools created during this thesis.

5.2 Tools

The SOPM process describes the tools needed for the Supplier Operations Project Managers to be able to lead the supplier in the NPCI – projects. Working with the supplier is challenging and leading an external company to meet the project requirements is critical for the success of the project. Tools don't add value to the process but they can make it easier to concentrate completely to value creative tasks and management. Target was to create effective tools with as much automation coded to them as possible while making sure that there is not going to occur errors or other delays while using them in daily basis.

The purpose of the tools is to support managers to achieve the defined goals of the project. The tools also drive the SOPM managers to use structured way to validate the suppliers and based on this validation to work with the supplier in order to prevent any future issues and quality problems. In order to reduce waste and make the work more effective project managers shouldn't use their time to anything else than managing the project. They wouldn't add value to the project by using their time to create templates for every project.

Tool creation started with defining all the needed tools from the SOPM matrix. Supplier perspective was taken into account while creating the tools which caused the tools to be created in Excel since it is a common tool for every company. Every tool was created by defining input, process and output. Defining the purpose of the tool, why is it needed and how to use it in a best way guided the creation. Although every project is different the matrix provided a guideline for tool creations since the main steps remind the same through every project.

SOPM TOOLS:	
Cover Page	Contains general information about the project, like scheduling, teams, suppliers and components in scope
SOPM Matrix	List of deliverables/activities that needs to be carried on over gates to execute the NPCI project with suppliers and internal stakeholders. From this Matrix, SOPM needs to select which deliverables/activities are applicable for the specific project
Progress Report	Form to be used by SOPM to track progress on all deliverables and to create a schedule for those deliverables. This is only for SOPM use not included to Supplier's file.
Supply Chain Map Template	Form for showing multi-tier supply chain relationships involved in providing the component/ assembly.
Supply Chain Map Example	An example of how a Supply Chain Map may appear.
Lead Time Breakdown	Tool used to analyze the supplier's capability to meet the lead time requirements. It can be used also to analyse sub-tier suppliers' lead times and to identify long lead times and possible bottlenecks.
Launch Readiness Checklist	Checklist to be used to verify Launch readiness at suppliers.
Key Metrics Report	Report for tracking the status of key metrics in a project per every gate. Report contains definitions of each key metric.
Key Metrics Graph	Graphical view through "spider charts" about Key Metrics results by each gate
Capacity Calculation Tool	Tool used to evaluate if supplier's capacity is able to fulfill the targeted volumes in different project phases. Supplier's own templates can be used also for this.
Production Prototype Approval Report	Report template to support verification of the production prototype
Prototype Report	Report template to collect Design for Manufacturability feedbacks from manufacturer, when producing prototypes or sample production parts.
Lessons learned	Template to collect lessons learned. Each Core Team member share lessons learned during the NPCI project.

Figure 9. *SOPM Tools*

As shown in the figure 9. tools include project management tools like planning and reporting, supplier performance measurement tools like lead time analysis, capacity analysis and performance metrics. Next chapters go through one by one every tool created to support the SOPM process starting with project management tool called progress report.

5.2.1 Progress Report

Based on the need of reporting the progress of SOPM to the project team the progress report template together with project cover page were created to support this task. The progress report is part of the file that is created at the beginning of every project for every supplier involved in the project. The report is taking input from the SOPM matrix and providing this information to the supplier. The cover page is gathering all the relevant contact information and deadline information to be shared with the supplier ensuring that this information is clear for both the company and the supplier. Cover page example is shown in the figure 10.

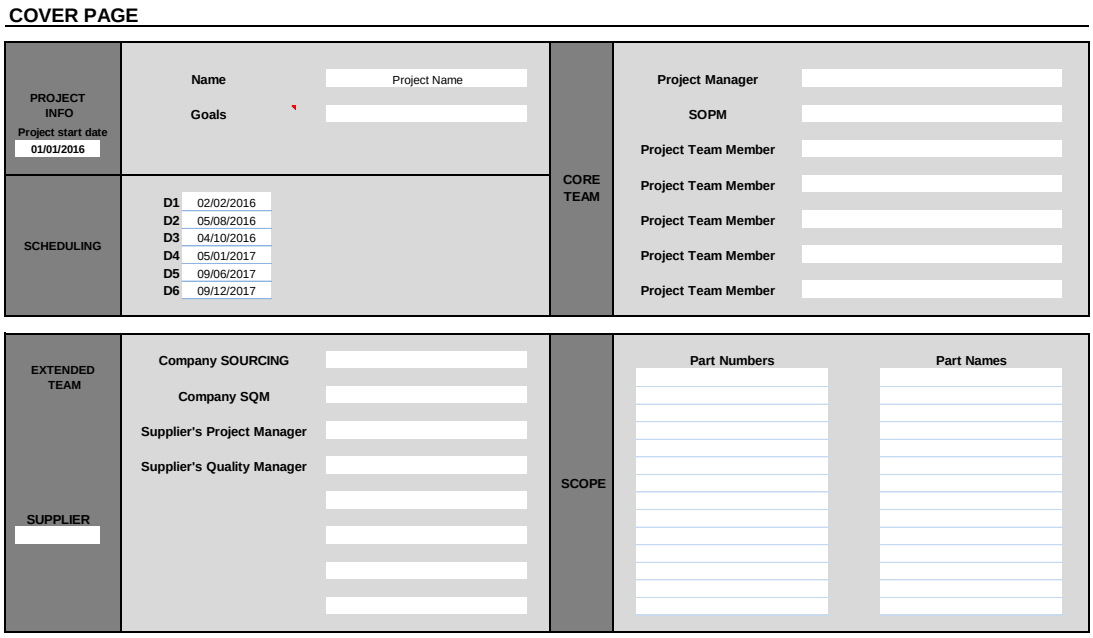

Figure 10. *SOPM Project cover page*

The progress report is used through the entire project and as an output SOPM can better lead the supplier and clearly show to the project team what is the progress of the supplier by showing the status of each task compared to the given deadlines. Example of progress report is shown in figure 11. In this case green means that the task is done completely and red means that it is not done and it has a risk that it is not completed before the deadline. This helps to keep track of tasks done and also it helps to raise early enough tasks that are considered to have a delay. This might help to get the task done sooner when the project manager can assign more resources to help with that specific task that has a risk.

PROGRESS REPORT

Project name:	Project Name
Supplier:	TestSupplier
Plant:	Finland

D2 PHASE

D2
DEADLINE
05/08/2016
31

Group	Deliverables	Activities	Must Have Reviews	Responsible person	Start week	Complete week	Year	Status
1. Project	SOPM plan is created and initiated	**1) SOPM plan:** Supplier's NPCI Project Manager, with SOPM, needs to create supplier's SOPM plan.	PREPARE SOPM PLAN	Supplier & SOPM	5	7	2016	G
		Provide leadership: Supplier's NPCI Project Manager needs to provide leadership to supplier's NPCI Project Team and take actions as necessary to achieve the next gate results in time.		Supplier	7	30	2016	G
		Schedule alignment: Supplier's NPCI Project manager needs to maintain schedule alignment with SOPM and manage own project risks relentlessly to keep the project in time.		Supplier	7	30	2016	R
		Status record: Supplier's NPCI Project Manager, with SQM Engineer, needs to record status of D2 deliverables and information into PQP file and deliver it to SOPM.	PREPARE SOPM PLAN	Suppleir	28	29	2016	R
		D2 progress report: SOPM needs to review and approve the Supplier's KPI D2 progress report.		SOPM	29	31	2016	G

60%

Figure 11. *SOPM Tool: Progress Report – D2 Example*

Since in every project SOPM needs to define which deliverables they are choosing from the matrix for each project and for each supplier the report template needed to be flexible. For this the template was created by using a macro to copy every chosen deliverable from the matrix into the progress report and with that reduce time.

5.2.2 Supply Chain Map

Supply Chain Map is one of the key tools to ensure that the company has the knowledge of supplier's supply chain and the supplier's suppliers belonging into that. The meaning of the tool is to get information about the suppliers involved in the Supply Chain for example if there is certain suppliers that the case company wants to avoid using and they don't want the supplier to use those as their suppliers. Also it helps to get traceability to the parts. Supply Chain Map as said in the chapter 3.6 is critical for leading the supplier. The figure 12. shows an example of supply chain map.

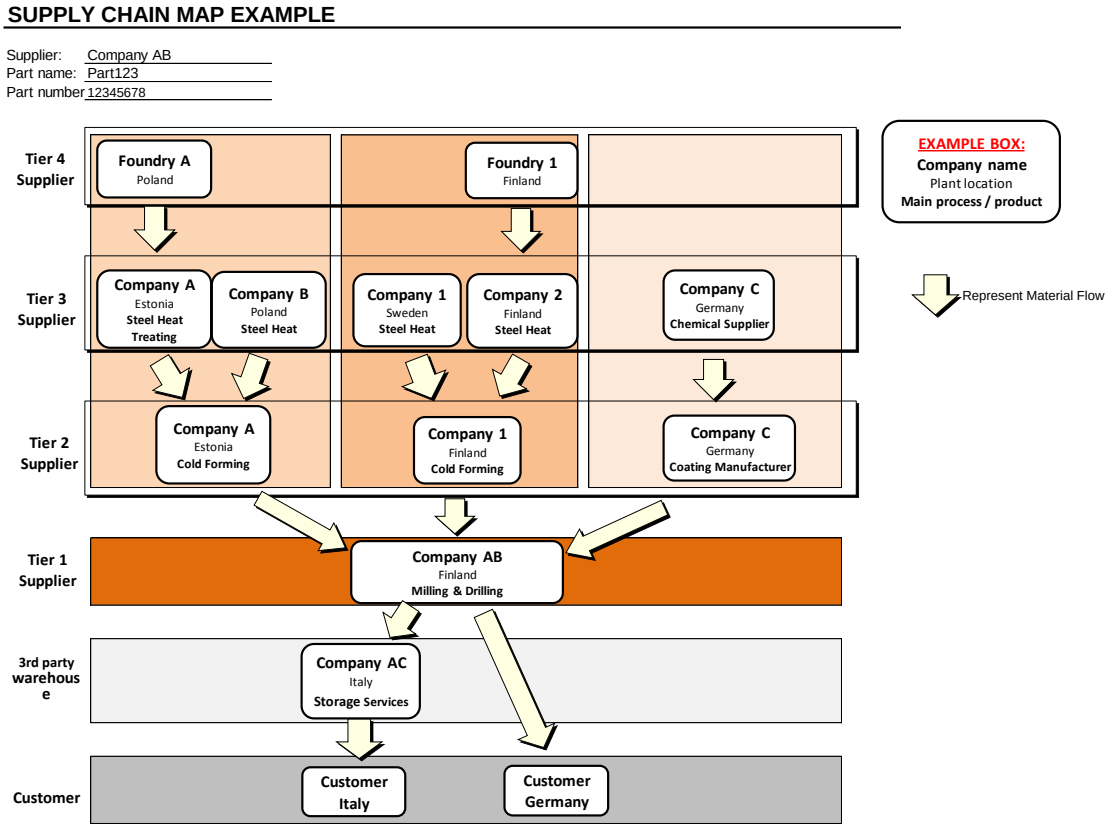

Figure 12. *SOPM Tool: Supply Chain Map – Example*

Different warehouses are also included to the supply chain map so that the case company will have the whole picture of the supplier's supply chain. Valid information by each supplier in the supply chain was defined to be supplier's name, country and the main process or product. The main process means for example painting or assembly. Supply Chain Map is connected to defining and validating the lead time of the supplier. Next chapter introduces the lead time breakdown tool.

5.2.3 Lead Time Breakdown

Lead time is one of the most important tools when dealing with projects. Every project has their deadlines which require specific planning and scheduling. Knowing the supplier's lead time helps to ensure the correct delivery on time. This is asked from the suppliers already before the project starts. Getting to know the supplier and its lead time helps to choose those suppliers that can meet the lead time requirements defined by the case company. Delivery has to be just in time because if it delays it delays the whole project which is expensive and also if it is too early it costs to keep it in storage. Also knowing the lead time with the longest possible way is helpful when company is doing a risk assessment. Knowing how much time in the supply chain it takes to change after modifications. Lead time is linked closely to the supply chain map.

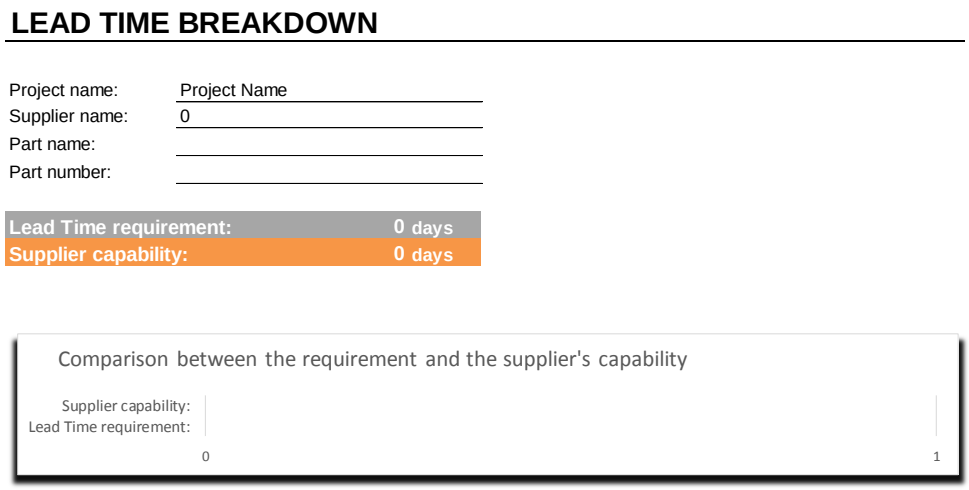

Figure 13. *SOPM Tool: Lead Time Breakdown analysis*

Lead time analysis tool needs to fit to many suppliers which means that it needed to be very flexible because the lead time analysis is attached to the supply chain map and every supplier has a different kind of supply chain so template needed to fit wide range of different kind of suppliers. Analysis part of the tool is comparing the supplier's lead time to the lead time the company is requiring. This is shown in the figure 13. The supplier's lead time consist of all of the supplier's suppliers lead times counted together. It breaks the supplier's process to five steps: order handling, production planning, manufacturing, packing and shipping and transportation. Between each step is added waiting time to get information about the waiting between different process steps. Waiting time should be minimized because it doesn't add any value to the customer. Third way to use the lead time analysis is to recognize non value added waiting times and help the supplier to develop their processes by using Lean principles. The tool is also making the supplier to think about their lead time if the supplier hasn't done that before. It provides information about issues and development topics.

5.2.4 Launch readiness checklist

Before launching the product and starting the actual production it is necessary to check that the quality of the product and the process is what is required and expected. The work of SOPM before the launch is to develop with the supplier the process quality and needed quality checks for the product. This checklist is the final check that is executed by the supplier alone or with the SOPM at supplier's factory. Topics to be checked are activities chosen from the SOPM process. This is essential to do so that before the launch starts the project team is able to prevent failures and quality problems which will increase the cost of the project. The main objectives as mentioned in a chapter 3.3 will be affected if the supplier is not ready when it should be.

LAUNCH READINESS CHECKLIST

General information	
Inspector group	
Date of the visit	
Project name	
Main process / product	
Supplier name	
Plant location	
Host	

ST	Strenght
SFI	Scope For Improvement
RC	Requires correction
NC	Minor nonconformity
MC	Major nonconformity

			Findings description & Classification					
Group	Deliverable	Explanation	Description	ST	SFI	RC	NC	MC
2. Sourcing	Supply Chain Map is confirmed	SQM Engineer needs to verify that the Supplier has up-to-date Supply Chain Map.						
	Supplier's capacity	SQM Engineer needs to validate suppliers capacity figures						
3. Quality	Traceability discipline is created	SQM Engineer needs to verify that supplier's traceability discipline is ready						
4. Manufacturing	Long lead time risks are mitigated for piloting	SQM Engineer needs to check that the Supplier has mitigated the risks of long lead time parts/ components for piloting readiness.						
	Preventive maintenance plan has been defined	SQM Engineer needs to verify that preventive maintenance plan for equipments and tools is ready.						
5. PPAP	Process Flow Charts are updated	SQM Engineer needs to review that supplier's process flow charts are updated.						

Figure 14. *SOPM Tool: Launch Readiness Checklist – Example*

The Launch report includes approving the production launch readiness and approving quality controls. These parts include detailed activities and checks that the SOPM needs to do. This is important to do in two phases because the first time helps the SOPM to improve the process with the supplier and establish needed quality checks. Also it gives time before the next check to correct possible gaps. And the second check gives still time to fix the last gaps before the production starts. The findings are described in the checklist if there is any and also evaluated for five different level of findings. It is important to note that a finding can be also a positive and it can be used as a learning also. The five levels are: strength, scope of improvement, requires correction, minor nonconformity and major nonconformity. This division helps the project team to make decisions about the next steps of the project. Minor and major nonconformities are defined to be findings that needs to be fixed before moving to the next phase in the project so they are causes for getting a nogo – decision and not be able to move to the next phase as descripted in the chapter 2.1.1. This is because they will have an effect to the quality of the outcome or the process quality which might show as a delivery delays and increased costs.

5.2.5 Capacity calculation tool

The capacity calculation tool helps to understand the production process of the supplier as well as the maximum capacity level of the supplier. The intention behind this tool is to get the supplier to think about their capacity and to find out what it is if they don't know. Figure 15. Shows an example of process details that could be taken into consideration when defining capacity.

Process details									
Product	Process	Amount of production lines	Shifts / day	Min /Shift	Changeovers (min. / day)	Maintenance (min. / day)	Other (min. / day)	Time availability (min. / day)	Cycle time per unit (minutes)
Product A	Straightening	1	3	420	20.0	30	400.0	810.0	35.0
Product A	Broach (Head milling)	1	2	480	10.0	30	300.0	620.0	40.0
Product A	K&T (End milling)	1	2	480	30.0	60	300.0	570.0	24.0
Product A	*Offline (Cuts, reendin	1	2	420	1.0	100	250.0	489.0	30.0
Product A	*CNC (X-holes)	1	3	420	1.0	20	800.0	439.0	26.0
Product A	Bundling (Packaging)	1	3	420	0.0	20	900.0	340.0	15.0

Figure 15. *SOPM Tool: Capacity – process details*

After validating the process and defining needed details the capacity calculation part is giving the actual capacity of given period. It takes into consideration available capacity and scrap rate as shown in the figure 16.

Capacity calculation					
Available capacity (units/ day)	**Time period**	**Days/ period**	**Available capacity in the given period**	**Scrap Rate**	**Actual capacity/ given period**
23	week	5	116	1.00%	115
16	week	5	78	10.00%	70
24	week	5	119	10.00%	107
16	week	5	82	0.90%	81
17	week	5	84	0.20%	84
23	week	5	113	0.00%	113

Figure 16. *SOPM Tool: Capacity – Calculation*

For project team this tool helps to see the supplier's current level of capacity and the maximum level of capacity if for example in the future the case company knows that the volume of the product is going to increase 30 %. This means that the project team needs to know if the supplier has the potential to increase the capacity if needed. If the supplier is already using the maximum capacity, then the project team will reconsider the supplier selection. Capacity Analysis is shown in the figure 17.

Capacity Analysis							
Target volume	**Preventive Maintenance**	**Contingency plan**	**Supplier 's usage of the capacity**	**Risk**	**Volume Forecast**	**Forecast impact to Supplier's capacity**	**Risk**
150	Yes	Yes	130.9 %	1.31	30.0 %	170.2 %	1.70
150	Yes	Yes	215.1 %	2.15	30.0 %	279.6 %	2.80
150	Yes	Yes	140.4 %	1.40	30.0 %	182.5 %	1.82
150	Yes	Yes	185.7 %	1.86	30.0 %	241.4 %	2.41
150	Yes	No	178.0 %	1.78	30.0 %	231.4 %	2.31
150	Yes	Yes	132.4 %	1.32	30.0 %	172.1 %	1.72

Figure 17. *SOPM Tool: Capacity – Analysis*

There are several ways of using the capacity calculation tool. The tool reveals in detail the processes of supplier and shows what kind of ways there is to increase the capacity if

there is a need for that. For example, by seeing how many shifts there is a day the supplier could increase the amount of shift which would increase the capacity also. The tool takes into consideration also the time that the process can't be used like changeovers and maintenance so that the supplier has to take that necessary time into account while calculating the capacity.

5.2.6 Prototype report

Prototype report is based on the concept of Design-for-Manufacturability. The report consists four categories: Standardization, Cost, Quality and Modularization. These categories ask three questions: what to change, why and how to change. The idea of the report is to gather information from the supplier who has better knowledge of its processes and with that all the development ideas are remembered to ask also from the supplier. The feedback or development ideas wanted are concentrated on the design of the product and its manufacturability.

DESCRIPTION OF VERIFICATION
WHAT
WHY
HOW

RESULTS							
Characteristics			**Production Prototype findings**				
Char. No	Drawing requirement	CtQ	Results 1	Results 2	Results 3	**Measurement Equipment used** Description	R&R

Figure 18. *SOPM Tool: Prototype report*

This report is one way of getting the feedback from the supplier and also a way to involve the supplier for the design phase so that the outcome fits better to supplier's process and

with that helps to keep the performance I desired levels. The feedback can be given at any point of the project but the target is to get the feedback and ideas as early as possible.

5.2.7 Key metrics report and graphs

Key metrics report was developed to measure the most relevant metrics for the project. These key metrics were left to be flexible which means that they can de increased or reduced depending on the needs of the project. the metrics are divided by groups used in the process matrix: Project, Sourcing, Quality, Manufacturing and PPAP.

METRICS REPORT

Project Name: Project Name
Supplier Name: 0
Plant location: 0
Part Number:
Part Name:

	Metrics	Explanation	Results D1	D2	D3	D4	D5	D6
1. Project	SOPM readiness	Number of elements from Supplier Progress Report with GREEN status.			7			
		Total number of elements from Supplier Progress Report			9			
	FRACAS	Number of closed FRACAS items			12			
		Total number of FRACAS items			12			
2. Sourcing	Target Cost	Target cost of the business case			100			
		Real cost			80			
4. Manufacturing	Test Achievement	Number of tests passed			3			
		Total number of tests			7			
	Work instructions	Total number of instructions completed			1			
		Total number of instructions needed			7			
5. PPAP	Supplier readiness	Number of records completed			3			
		Number of records required			3			

Figure 19. *SOPM Tool: Key Metrics Report – D3 Example*

For the project it matters how ready the supplier is and what is the status of supplier's activities. Like in chapter 3.3 the project triangle is presented with three main success factors which are quality, time and cost. For the time these metrics selected are evaluating the readiness of the supplier which means that the time reserved for the certain activities is used and there are no delays. Also delays will increase the cost so supplier's readiness on time will affect to the cost level of the project. To support the metrics and to ensure that the project team is getting a clear picture of the current situation. The key metrics report is supported by key metrics graph where the results are shown more clearly.

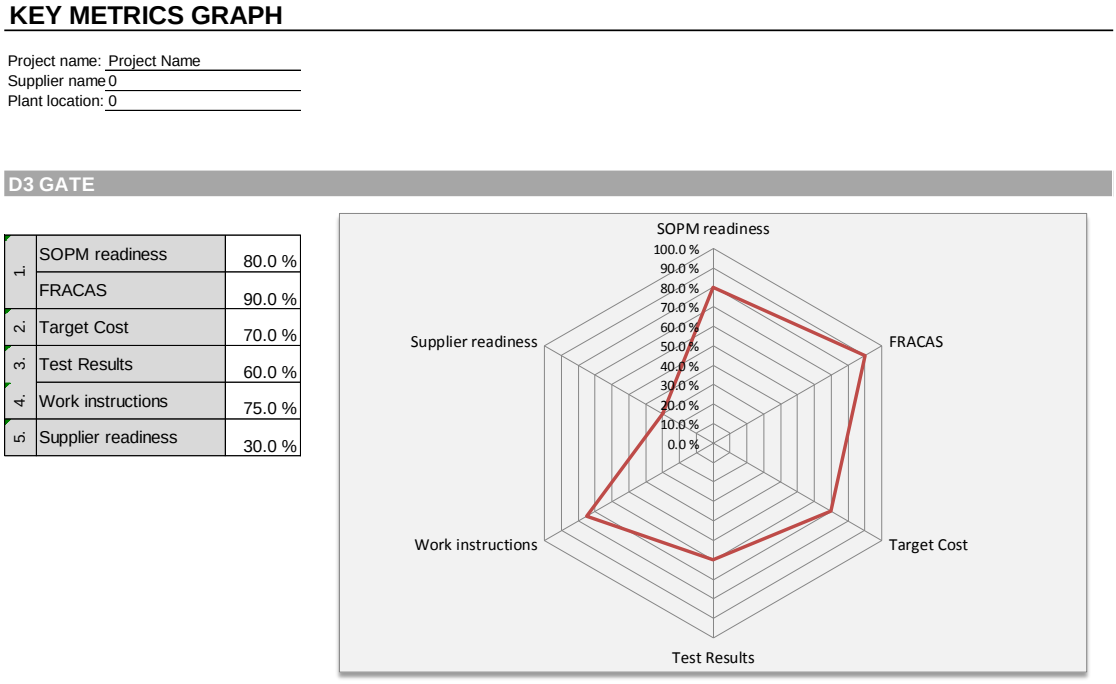

Figure 20. *SOPM Tool: Key Metrics Graph – D3 Example*

5.2.8 Lessons learned

Lessons learned is a report developed for internal knowledge gathering from all the project team members and also to get feedback from the suppliers that were involved in the project. Lessons learned can be positive and negative. The reason why this template was created is mainly now when the process is new and the tools are new to gather feedback from those. But also lessons learned are used to gather information about what went wrong in a project or what went really well. These learnings are then shared inside of the company to find the best practices and also to avoid making the same mistakes.

Lessons learned is also a way to record and follow the status of improvement action. To ensure that the needed actions are taken there is always an owner for each action who monitor the development of action and follow it through.

As a summary the main results were the tools created to support the SOPM process that is part of the NPD process. As the tools were developed based on the SOPM process needs it was important to create them to fit to the daily work. Result was also published in scientific peer reviewed article in 24th International Euroma 2017 Operations Management conference. The next chapter is the final chapter of the thesis called conclusions that evaluates the thesis work and methodology used by considering four conditions: Construct validity, Internal Validity, External Validity and Reliability. It also introduces the main thoughts and improvement ideas for further development.

6. CONCLUSIONS

"Strategy is no longer a game of chess because power no longer depends on nodes, but on networks." (Satell, 2014)

This citation describes very well the current situation in the market where companies operate. The limit of resources and capabilities compared to the expectations and technology development has driven the companies to innovate in a new way. Networking and finding the right suppliers and partnering with them has become critical. Big companies that are driving the markets are developing their suppliers to be better with continuous trainings and performance reviews.

As shown in the results this thesis concentrates on the supplier operations project management process and tools. SOPM was taken into consideration since it was seen how the market is developing and the need of using the suppliers in NPD projects is increasing. There is a great chance of risk when the project team is big and partly external. Leading an external suppliers and getting them engaged into the project is a challenge. This is why selecting a right supplier to the project is critical. Too often cost is major driver when selecting suppliers. SOPM process considers the cost and the capabilities. Before supplier selection the SOPM needs to evaluate the potential suppliers and their capabilities. This is supported by the tools created.

This work was done when the company was still in a development phase of a new process for new product development which made it impossible to gather information if targets set to the new process were met. Developing a new process takes time and the implementation has already begun but the nature of new product development is quite long which means that to get a clear picture of the results is going to take several years. Estimation of the benefits of the tools is that time used before for creating the tools for working with the supplier was around 20% of the time per project manager. And now with introduced tool set that time can be completely used for actual daily work and not creating support documents.

6.1 Theoretic contribution

The theory part of this thesis is an overview on literature concerning structured new product development process combined with open innovation, project management with suppliers, early supplier involvement and supply chain management in a new product development project. The case study shows a one way of combining all this theory together and implementing it into the practice. It also highlights the importance of selecting a good supplier for the project and how important it is to lead the selected suppliers in order to achieve the targets.

The case study furthers the literature on networking, open innovation and the State-Gate model, by providing a clear strategy on the main actions needed in achieving early supplier integration and identifying needed resources and skills that the SOPM needs to have in order to establish an effective collaboration between the company and supplier.

6.2 Practical implementation

The practical implementation of the study was the creation of the SOPM matrix and tools for the case company. The case company's NPD process is following the theory of the State-Gate model. As the State-Gate clearly says defined structure in a project helps to proceed and keep the project on time. The idea of open innovation drives the mapping process to start also on suppliers' side. The SOPM matrix goes into detail level of every task related to specific topic and describes all the tasks that need to be done before entering to the decision gates that control the project.

In this thesis is introduced in the results section in Figure 9. an excel tool content table. The tools were released to the company in three rounds. In the first round the planning tool was introduced. The second round capacity management and supply chain map were introduced and in the third round all the rest. Lead time analysis, capacity analysis and supply chain map are tools to evaluate the fit between the company and supplier now and in the future. Finding a good supplier is not enough as mentioned in the chapter 3.6 even proactive suppliers need support from the company to tell them specifications and what exactly is needed. Progress report, launch readiness checklist and key metrics are tools to support project management part of the project helping to lead the supplier during the project. Not having skills to lead the external supplier during the project might cause a big risk of delays. Sharing information and making sure all the relevant information is communicated clearly to the supplier is critical. Most difficulties during the project are caused either having a bad supplier or having a bad communication. Assuming that the supplier knows without telling is dangerous. Final tool called lessons learned is trying to get the problems and best practices recorded from every project so that the most value of the project is captured as mentioned in the chapter 2.4. Making the same mistake in every project is costly so what companies try to do is to learn from every project and avoid doing the same mistake or trying to copy the best practice into the next project.

Based on latest empirical evidence I can argue that with the new SOPM tools and process the NPD project's lead-time evidently will decrease while quality will stay in the same level through the whole project.

6.3 Evaluation of the thesis

The objective of the thesis was to create the tools to support Supplier operations project management in new product development projects. For this purpose, the thesis is looking for answers to questions on How to select a right supplier for the project? How to involve

the supplier in new product development projects? How to lead the supplier during the project?

The tools developed to support the SOPM process are highly supporting the supplier selection which was one of the main questions mentioned. Validating a supplier should include validating supplier's true lead times, capacity and supply chain since these all are part of evaluating the supplier's capabilities and risks of choosing the supplier. And even though the project team would choose a supplier whose quality level is under the accepted level but might have other capabilities then at least there shouldn't be any surprises later on when the supplier's capabilities and performance is well evaluated before. In these cases, SOPM would need to start working a bit earlier already driving the supplier development towards the accepted level. Also evaluation of the supplier is better to come from a person who has already experience in that area and knows how to do an audit and evaluate the supplier's processes, capabilities and culture. Theory talks about supplier development and how important it is to develop suppliers and how company will benefit from it. Now that we are also talking about partnership with suppliers and how suppliers are going to be even more part of new product development the questions could be also while concentrating on evaluating the supplier that how can the supplier develop the company? What kind of capabilities the supplier might have that they might give to the company? Not only thinking only how to select a supplier and then develop them to be something the company needs. This thinking is still a bit inside of the box. We need to see outside of the box and think how the supplier could develop the company. That's why I would add later on that kind of thinking to the SOPM model and also to the new product development. ESI concept is already taking that kind of view on things since it takes the supplier to be involved in the early phase. But before even starting a project companies could benefit from suppliers' knowledge and capabilities and get development ideas from them. The environment where companies operate is changing so fast that there is not necessarily time to develop the suppliers. For innovation support from the supplier is more important than first learning everything by yourself and then developing the supplier. As an improvement idea I would add suppliers creative and innovative capabilities to be one of the key factors when selecting a supplier. And this wouldn't mean only when selecting strategic suppliers because sometimes an idea in a less meaningful part might end up being something vital in the competition. For this sourcing would need full support from R&D engineers who have deeper understanding of the product and technology development so that evaluating these factors would be possible.

To answer to a question how to involve the supplier in new product development projects, the process is following the theory of the State-Gate model combining the concept of open innovation and project management. As the State-Gate clearly says defined structure in a project helps to proceed and keep the project on time. The idea of open innovation drives to start mapping out the process also in suppliers' side. The SOPM model goes into detail level of every task related to specific topic and describes all the tasks from D0 to

D6 which are the decision gates as Cooper mentioned to control the project. Mapping out the process based on theory but also based on the actual knowledge and learnings of professionals was really interesting. There are no books that can describe that level of knowledge. The tasks tell you who exactly needs to do and what. It also tells you why. This was seen as a critical because understanding why you are doing the task helps to be motivated to do it and better understanding helps to get the best and correct output. Too many times it was seen as a problem when there was not clearly stated whose responsibility was to finish the task and then it at the end was project managers trying to finish tasks. The structured process gives a lot of benefits when it is transparent to every team member what the other one is doing. Also mapping out the critical path with definition of must have helps to get the big picture since there might be other team member waiting for some task to be finished before he or she can start. This critical path also helps to understand what the supplier needs to do in their side also to be able to identify risks in lead time and ensure the quality is in a right level. The structured process doesn't solve the issue of lack of resources which is a problem in a lot of companies since the resources are limited. Even though it is now more transparent and shows better the resources needed it doesn't give any extra resources. In this case the more important thing to do is to select more carefully the projects that the company will start to develop. As Cooper mentioned in a chapter 2.1.1 that the research shows that 44% of projects will not succeed it is highly critical to have good evaluation criteria for choosing the projects in order to get the biggest benefits. When the SOPM matrix will be further developed having a lighter version of SOPM matrix by decreasing must haves and other deliverables for lighter projects would be beneficial in practice. Since projects are different some of them might be able be done in a lighter version which means less resource needs and less time used for that project and this releases resources to be used in other projects.

The result of this thesis shows that the company needs to adapt its internal processes and organizations for supplier collaboration. To answer a question how to lead the supplier during the project having a member responsible of leading the suppliers in a core team is necessary in order to keep the communication and information sharing open. As mentioned in the chapter 3.6 the result in a case study done in auto industry shows that even though suppliers were encouraged to act pro-actively and even they tried to act that way the performance was low and company needed to intervene and help suppliers to solve problems. This shows that the performance is heavily dependent on the company's role in the relationship which supports that the company needs to have a core team member responsible of leading the supplier in a project. This in the other hand shows then a need for adapting the company's organization and its internal processes for supplier collaboration. The field of project management is well known and there is a lot of theory established and the same goes from supplier selection to supplier's early involvement but there is not actual structured practise in the companies how to involve and lead the suppliers in the NDP projects. Even with the case company there is still a lot of details that needs to be taken into consideration but the baseline is now done. The case company has the tools

and the process to follow in the project but deciding which deliverables to choose for each project and executing the tasks is still a job that can be done many ways. This can be seen as a threat but also as a strength. After all employees are not robots and we can't control how they work completely or at least we shouldn't. The process, the must haves and the tools give a good guideline for the job and with right people and with right suppliers it will carry a long way. Other thing that is critical to understand is that every project is different and every supplier is different so SOPM model provides a really good base to start building the project but the SOPM also needs to have skills to lead people and good problem solving skills for very different situations. There is no definition of how many deliverables SOPM should select from the SOPM model but the critical path is marked with must haves. These deliverables are must so it keeps the risk of something really important to be forgotten in the minimum level. Selection of deliverables is based on knowledge and experience. Also the model doesn't define how long each task will take. It is impossible to define since every project and supplier involved is different. Knowing the supplier since from the beginning helps to define part of the deliverables. If the supplier is completely new it means that SOPM also need to ensure basic things like order management to ensure that the supplier can receive and deliver orders without having any problems. This is really basic thing but might be forgotten when the project might last several years. Also to get feedback from the supplier as a DFM to be able to use the knowledge of the supplier and to fit the product designed to the production of the supplier without having major quality issues and also to have a good process quality. What is the supplier perspective in the NPD projects? How to make the supplier understand why this project and being involved is good for the supplier and what are the benefits besides of getting more sales maybe if the outcome is successful. To understand the drivers behind the supplier and motivation to be able to improve the collaboration with the supplier. For supplier it is risky to give so much of its resources to one project that it might happen that due to lack of resources the supplier is delayed in a project which means that the whole project is delayed. But how can you as a project manager know this beforehand? This requires a lot of knowledge of the supplier and means that when the project is starting the supplier side of project management needs to be taken into the project as early as possible. This helps to identify together with sourcing the potential suppliers and with created tools to identify the strengths, weaknesses and potentials of the suppliers.

The selected methodology for this thesis is case study with research design. Research questions are set in the beginning of the thesis to guide the work. The main focus was to see the problems in reality and with theory to answer to those questions by practical tools and processes. This real-life context gives deepness for the thesis and practical view for the theory. Thesis consist a lot of how and why questioning during the tool development. It takes the theory and best practice knowledge from experienced professionals and combines these two into reality for daily work. This thesis is single – case study since the thesis has only one case company under evaluation. The circumstances are unique in this

case since every company has different combination of NPD processes, culture and capabilities and knowledge of the employees. The amount of suppliers used in a project is increasing which also creates unique situations where the new tools are tested. The case study methodology's purpose is to illustrate the specific topics within an evolution. In this case the development of the State-gate model to involve also the external suppliers. As mentioned before for research design it is necessary to have four conditions: Construct validity, Internal Validity, External Validity and Reliability (Yin 2003). Construct validity condition shows in the thesis in the process and in the tools. The State-Gate theory was heavily used to develop the guideline for the process that was later on improved by experienced professional with their knowledge. The needed tools were developed based on the theory of importance of supplier selection and how to measure suppliers and then later on fixed to fit into the developed process and the case company's needs. Since the case company interacts with changing market needs and technology development is fast the tools will be improving over time and probably changed from one software version to another but the main idea stays the same. Validating the supplier's capabilities and knowing them is relevant for the companies and for the project in order to achieve the targets. These fulfil the internal validity condition and external validity condition. Also the criteria when selecting and validating supplier provided by theory can be generalized which means that the tools can be generalized. Also the tools are not depending on the different projects because suppliers need to be validated in every project. This provides reliability as the research design is asking for.

There is a lot of pressure towards the project team during the project. The pressure comes from different directions, from internal stakeholders and externally from customers. When developing a new product, quality is one major influencer of the success of the project. Customers are expecting a good level of quality which level the company defines from the inputs it gets from the customers and also inside of the company from the top management. Quality level is defined before the project execution starts. During the project the company tries to keep the defined quality and also after the project the quality of the outcome should meet the quality expectations. Otherwise after the project there is big amount of corrective actions which are improving the quality of the outcome to be the same than the defined expectations. These corrective actions can be very expensive for the company and also quality problems will have an effect to the customers for example as a delayed delivery. Since the tools were implemented in three rounds there was some feedback received back from the SOPM managers and improvement actions were taken based on that feedback. After all the target was to make their work easier. Most of the feedback was related to the manual work needed to be done in excel and some were able to be fixed to automatic but my recommendation is to change in the future some tools to Microsoft project kind of tool at least the project management part of the tools. Project team needs to have some knowledge of suppliers and their working style and quality to better get exactly what is needed from the supplier. For this supplier integration to the process is very important so that we can have committed suppliers in the project that care

about the outcome and maybe help the project team to understand better what they can develop.

6.4 Future research topics

Researchers are often referring to different sourcing related trends but concrete data how different companies are in practice involving their suppliers into NPD projects is scarce. The aim of this thesis was to show one way of supporting the NPD project by creating a process involving supplier responsibilities and tools to support the process. Result was also published in scientific peer reviewed article in 24th International Euroma 2017 Operations Management conference (Aramo-Immonen et al. 2017).

For further research ideas the theory behind combining internal NPD process with open innovation and other approaches like LEAN would be interesting to see and finding why companies are struggling with NPD projects and what are the possible threats that the working with the supplier might bring in order to avoid these. Other research idea is to review how companies globally are leading their NPD projects and what are the best practises. Third research idea is how to measure the suppliers' capabilities even better involving creative and innovative capabilities since those will be needed when suppliers part in NPD projects are increasing fast. This would help to select the suppliers even better when the evaluation criteria would take into account also more the future driven targets and needs.

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